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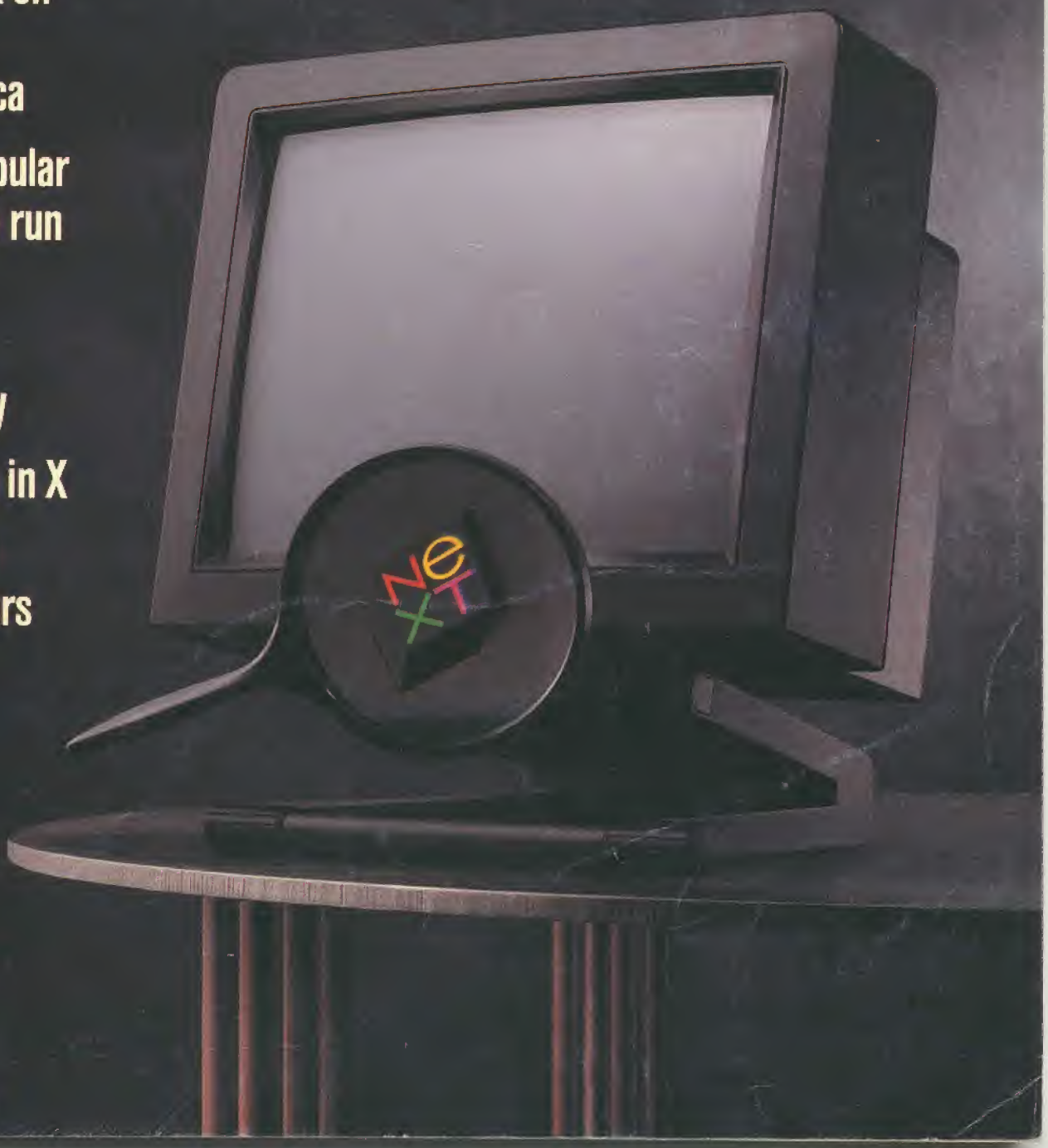

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A UNIX MACHINE FOR ALL REASONS

The Next computer is not just a pretty face. It has some brilliant things to offer both mere mortals and applications developers

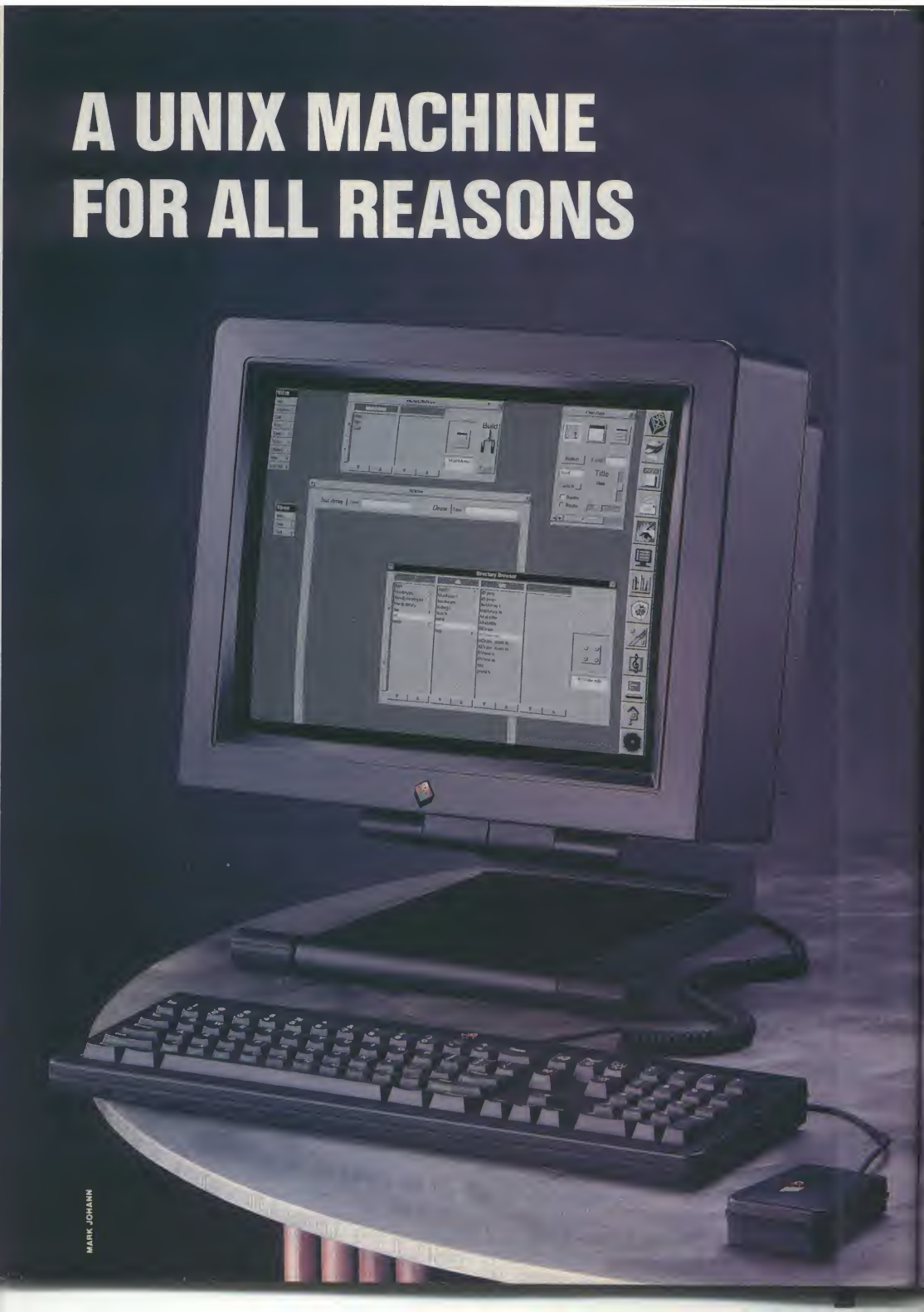
By Rik Farrow

Finally! A UNIX computer that does a good job for both "mere mortals"—those who use software applications—and for developers—those who write them. And best of all, the integration of both environments is seamless.

For the mere mortal, the Next Workspace Manager provides an intuitive, naive-user front end, and, just as important, enough bundled free software to make it immediately useful. For the application developer, there is a complete BSD 4.3, including an **emacs** editor, Network File System (NFS) support, and a tool for creating Next-styled user interfaces. This combination of applications, point-and-click interface, and a fully featured UNIX system makes the Next computer the most complete UNIX system I have reviewed.

But there is a catch (of course). Before application developers can start writing for the Next environment, they must learn something about object-oriented programming and working with the Next windowing system. The time lapse between the release of the Next and the availability of quality software has most potential users standing back and watching.

And everyone wonders how software will be distributed when the removable media cost $100 ($50 for higher education). So far, the Next



MARK JOHANN

computer's only removable storage media is the optical disk, unlike the Mac II or Sun 386, which use 3½-inch floppies. The concept behind the optical disk is that the Next user can carry his or her world in a briefcase or backpack. Each optical disk can store 256 megabytes reliably, as opposed to the 3½-inch floppies' 1.2 megabyte capacity. The Next user can move from machine to machine with all the files, data, and software that is used on the user's own machine.

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Apparently, Steve Jobs views the Next as becoming as common as, say, photocopiers or fax machines. While I'm not going to make any predictions about the success of Next, I can think of worse things that could happen.

Easy-To-Use Software

The Next computer is easy to use. You start up the Next by touching the power button on the keyboard. Within about six seconds, a quiet "beep" is emitted by the display and a testing system message appears. Twenty seconds later, a "Loading from disk" message appears, with an animated image of a disk spinning. Almost a minute passes before either the Workspace window or the log-in window appears, and the system is ready for use. By comparison, the Mac II could boot Mac OS (the Finder) in under 10 seconds, but took as long or longer to boot A/UX.

Until passwords are added, the Workspace Manager starts up immediately under the auspices of the user "me." The initial display shows the Directory Browser in center screen, a menu in the upper left corner, and a column of icons along the right edge of the screen. Although this screen layout does not resemble the Macintosh Desktop, most Mac users that I introduced to the machine quickly understood how to use the Workspace.

What I find so remarkable about the Workspace, and the Next, is that here is a complete UNIX system that is hidden from the user uninterested in UNIX. A point-and-click interface moves them through the directory hierarchy, and double-clicking launches applications. The boot process is initiated from the keyboard, and the system can be halted in five seconds also by pressing the power button, after confirming the decision to power off. Power UNIX users who prefer seeing the entire UNIX hierarchy can activate this by using the Preferences application, and terminal emulation windows can be used instead of the Browser. I preferred to use the Browser for looking around, and worked in terminal windows only when I wanted to execute UNIX commands.

Most new UNIX systems include only the "core" set of programs—the minimum necessary to boot UNIX and run a shell to use a handful of file manipulation commands. The Next includes all the commands and resources of Berkeley UNIX, and much more. Let's talk about some of the bundled applications first.

Next provides a version of WriteNow, a word processing programming that is also ported to the Mac. WriteNow is a WYSIWYG word processor based on top of the Next Display PostScript windowing system. I spent 30 seconds explaining how to use it to my wife (without reading the manual myself), and left her alone. A complete novice, she was able to write and edit letters, print them, and run the spelling checker, and never once called me at work with problems (with the Next). I was impressed.

The Digital Librarian is a high-speed text-retrieval program. For me, the most important use of the Librarian was to peruse documentation. By entering a keyword, say `nfs`, the Librarian would locate all references to the keyword, and start the appropriate application for viewing the first document found, with the keyword highlighted. A browser shows all the incidences of the keyword, and clicking on a line allows viewing the document at the point the keyword occurs. All UNIX reference manuals are included, along with Next documentation and manuals for the bundled software.

Besides manuals, Next included some school-oriented books. Miriam-Webster's Ninth Collegiate Dictionary (with illustrations, 41 megabytes), Webster's Thesaurus (4.4 megabytes), Complete Works of William Shakespeare (11 megabytes), and the Oxford Quotations (5 megabytes) consume a total of 61 megabytes of storage. I would be willing to part with some of this. The Digital Library can also be used to index your own notes, letters, and other works, making it easy to find any of the letters you ever sent without having to invoke `grep` on many directories. The Digitial Librarian uses an indexing scheme for fast look-ups in nonstructured (text) files.

Mathematica is another scholar-oriented program (see review on p. XX) that comes bundled as standard system software. The Next version includes a hypertext-style notebook facility, where any marked line can be expanded for more detail by clicking in the right border. Mathematica is also an arbitrary precision calculator, designed to handle complex expressions, and can plot data in both 2-D and 3-D.

The version of Next I reviewed (.9) did not include the Sybase Personal Database application, which will also be bundled. Sybase is a full-featured transaction processing engine. Sybase on the Next will respond to requests from other Next machines across the network, but not other computers on

The 400-dpi Next laser printer is entirely controlled through the cube, including the translation of Display PostScript into a raster image.

the network unless additional licenses are purchased.

Other bundled applications include Electronic Mail (with a voice mail capability), the Preferences application, terminal emulation, a scrolling shell, another editor, some games, and the Interface Builder.

For me, the Interface Builder was the most important application. The Interface Builder is the tool that *must* be used to create new applications for Next. At first glance, Interface Builder looks like the HyperCard programming tool for the Mac. The Interface Builder allows you to drag buttons, menus, sliders, text forms, and more, into the project that is being built.

Throwing the big, Frankenstein-style switch allows testing the new interface before a line of C code has been written.

These controls can be connected to other objects by dragging a connecting line between the objects. Throwing the big, Frankenstein-style switch allows testing the new interface before a line of C code has been written. I quickly built an application with a slider and a text object, where manipulating the slider changed the value displayed in the text object. However, going beyond that proved more difficult.

Next uses Objective-C from Stepstone Corp. Objective-C uses a preprocessor to add an object-oriented layer to the C language. Object-oriented applications can take advantage of data hiding and encapsulation, and runtime binding, that can produce flexible applications. The Interface Builder gives access to the 44 classes of objects currently available for building new applications, and will also create a Makefile and "stubs" for new objects. The "stubs" are partially completed Objective-C programs that can be compiled, but won't do anything until more code is added.

And there's the rub. It takes some training before a C programmer can start using Objective-C, and still more training to use the Interface Builder to create applications for the Next environment.

I succeeded in creating a new class, the part of my benchmark that calculates 100,000 points. My program would run—with the Next calculating the points in seven seconds—in the same class as the Sun-4 or Personal Iris. But I could not get even an X displayed. At this point, I sought help from Next in writing the display portion of my benchmark program. The listing of this module is shown in Listing 1, and the results of running the benchmark—and comparisons with the Mac II running A/UX and a Sun 386—are seen in Table 1.

Next offers a relatively inexpensive ($750) four-day workshop on programming in the Next environment. I definitely recommend it. There is a big difference from the old style of programming where the program is in control, and the point-and-click variety where the user decides what to do next. Developers for the Macintosh have already discovered this. And using the object-oriented programming style takes some getting used to. However, as more objects (just think of objects as programming modules) are developed, writing new applications becomes easier, because these objects can be reused. The term that Stepstone prefers for these modules is "software ICs" that can be plugged in and used.

Display PostScript is the base for the windowing environment. It seems fast enough, and solves the printer problem—that is, the same code that drives the screen display works with printed output. The problem with this

Listing 1: The drawing module for the Next benchmark uses an array created with an `initArray` module similar to `function` used in other benchmarks.

```
/* Generated by Interface Builder */
#import "RView.h"
#import "dpsclient/wraps.h"
@implementation RView
+ newFrame:(NXRect *)rect
{
        self = [super newFrame:rect];
        [self createOpsArray];
        return self;
}
- setDrawForm:anObject
{
        drawForm = anObject;
        return self;
}
- draw:sender
{
        long time();
        long start = time(0);
        int i, group;
        [self lockFocus];          // Direct drawing at the current View
        PSsetlinewidth (0.0);      // Use thinest line width
        PSsetgray (NX_BLACK);
// DPSDoUserPath draws a Postscript path with the following arguments:
// array of points; number of points; type of points; array of dps
// operations; number of operations, boundary of drawing area, action
// to perform for path given.
// Due to a limitation with size of the array given to DPSDoUserPath we
// must cut it into groups of size NUM_OPS.
        [ drawForm setStringValue:"Drawing to buffer" at:0];
        for ( group=0; group < NUM_GROUPS; group++) {
              DPSDoUserPath (&data[group*NUM_OPS], NUM_OPS*2, dps_float,
                ops, NUM_OPS, &bounds, dps_ustroke);
        }
        [ drawForm setIntValue:(time(0) - start) at:0];
        [self unlockFocus];
        return self;
}
// Create an ops[] array that has moveto as the first element and
// a lineto per point. This array gets passed into
// DPSDoUserPath as the array of PS operators...
- createOpsArray
{
        int cnt;
        ops[0] = dps_moveto;
        for (cnt = 1; cnt < NUM_OPS; cnt++) ops[cnt] = dps_lineto;
}
@end
```

approach is that the Next environment is not a standard environment, and vendors must create a port specifically for the Next.

When this machine was reviewed, the X Window System was not available. Some people think that it is a mistake not to support X Windows, but I'm not so sure. My experience so far with creating *portable* X11 applications is that the application either must be willing to use the lowest common denominator display server, or become incredibly complex internally. Because the quickest way to get a port working is to use the basic features, most X applications will be stuck using the same resources whether the server is a Silicon Graphics workstation or an X terminal. And this implies that the first X applications will have lackluster appearance. So having a proprietary display may make Next harder to port to, but will produce more consistent and pleasant to use applications.

Anyway, this discussion may be moot soon, as the Massachusetts Institute of Technology (MIT) has ported X Windows to Next. It will be available soon at a nominal fee, say Next officials.

I noticed some peculiarities in the UNIX system used in the Next. It disturbed me that the home directory for the user "me" was in the root directory. Usually, it would be in a separate partition, so that users consumed disk space in their own file system. Next only has a single, large partition on the optical disk or the 330-megabyte hard disk. This is a BSD Fast File System, which partially accounts for high performance of the optical disk. My problem with this setup is that when the file system fills up, the user will be frozen. Only the superuser can utilize the remaining disk space (10 percent is reserved by default). And the Next does nothing to prevent a user from running out of disk space, to select files for removal, or even to understand what the "superuser" is or can do. I was told the 1.0 version would warn the user before carrying out an operation that would wipe out the remaining free space.

The Mach kernel supports multiple execution paths within a single process.

Another difference appeared when I attempted to add new users by editing the `/etc/passwd` file. Nothing happened. It turns out that Next's NetInfo system does something like Sun's YellowPages. If you use the Berkeley `nu` (new user) command to add new users, the NetInfo system is informed of the changes to the real password file, and everything works. NetInfo is designed to automatically administer to a network composed entirely of Next machines on thin Ethernet. I was pleased to discover that Next had not made the same mistake that Sun did with the Sun 386—assume that the network would have nothing but other identical computers on it. The NetInfo documentation describes how to make the Next computer function with other computers on the network.

Next is planning to improve the NetInfo application to make system administration easier. At this point, I see administering to a Next—or a network of Nexts—as a big problem for nontechnical users. Next does provide training for service personnel at institutions that are acquiring Next computers (which are several universities, so far).

Last, but not least, Next uses Mach. Mach is a new operating system kernel that can run 25 percent faster than a UNIX kernel. Mach supports loadable device drivers, permitting programmers to add and test the drivers without relinking the kernel or rebooting. The operating system is not compliant with Posix.

The Mach kernel supports threads, that is, multiple execution paths within a single process. Threads provide a natural means for supporting multiple processor systems. Although the Next (currently) boasts only one CPU, programs written on the Next using threads of execution can take advantage of multiprocessor support when it becomes available. Other boards could be added to the Next with multiple processors. Or, threads for color displays could execute on independent processors across the NuBus. Threads can also execute on other machines, even different architectures, across the network.

Table 1: Comparison of floating point performance, line drawing speed, and price between three workstations specializing in user-friendly front ends.

	Initialize 100,000 Points	Draw 99,999 Lines	Price
Next	7	111	$10,000
Sun 386 *	11	165	$25,000
Mac II-A/UX **	40	390	$10,000

* Price includes a 327-megabyte disk and floppy drive; benchmark program is the same as the one used in Solbourne review (May 1989).

** These times were extrapolated from times acquired during the A/UX review (July 1988) by multiplying the values for 10,000 points by 10.

Clean and Simple Hardware

The Next hardware is a good example of the way I believe computers should be designed—clean, simple, and beautiful. The cube and display are attractive, something you can't say about most computers. All the connections on the back of the cube are clearly labeled. And each type of connection has a unique form factor—for example, you cannot plug the laser printer into the SCSI port by accident. I set up the Next without ever cracking open a manual.

The Next cube contains contains bays for two full-height 5¼-inch storage devices, such as the standard optical disk or an optional hard disk. The cube also contains a 32-bit NuBus with four connectors. Only one of the connectors in the cube is used. Next was scheduled to begin supplying the technical specifications for the NuBus and sample interface chips in August. Quantities of the interface chip should be available from Next in October at low cost.

The processor board is a work of art. There are no small wires used to correct design flaws, demonstrating that this CPU board is flaw-free. Next uses the Motorola 68030 along with the 68882 math co-processor, both running at 25 MHz, faster than the Mac IIx, which uses the same chips running at 16 MHz. The 68030 processor includes both data and instruction caches and memory management on-board. Next comes with 8 megabytes of 100-nanosecond (ns) RAM, expandable to 16. A thin Ethernet port is also included, which provides complete compatibility with other Ethernet networks.

continued

The optical disk controller is a custom very large-scale integration (VLSI) chip designed by Next. It not only controls the optical disk, but also communicates with the SCSI controller, which can transfer data at 4 MHz, and the serial controller, which is connected to ports using Mac-style (DIN 8) connectors. Both serial ports can handle 230.4 Kbits/second synchronous (same as Apple's LocalTalk), or 38.4 Kbaud asynchronously. Cayman Systems has developed a gateway product called the GatorBox for connecting the Next to Macintoshes on Ethernet or LocalTalk networks.

The channel controller is the second VLSI chip designed by Next. Channel controllers are used in mainframes to provide fast data paths between main memory and peripherals independent of the CPU. The Next channel controller has 12 direct memory access (DMA) channels that manage all data transfers between I/O and memory. Using the DMA channels frees the processor from data transfer operations, sharing the dual-ported main memory with the CPU (having dual-ported memory is like having two doors—one for the CPU and a back door for the DMA). This design sets Next apart from most other workstations (Suns, Mac II's, MicroVAXen, for example) which use the CPU for handling data transfers, assembling Ethernet packages, and so on.

The Motorola DSP56001 CMOS digital signal processing chip gives the Next a real-time capability. The DSP56001 is a high-speed special-purpose processor (10 mips) that functions independently of the CPU. It has internal memory, plus 24K of fast SRAM, and can be used for Fourier transforms, digital filtering, data collection, or music. It is this last capability that has many people excited. The DSP56001 can produce CD-quality stereo sound, turning the Next into a first class musical instrument. A product called "Digital Ears" is available for turning a Next into a two-channel digital recording device. The DSP56001 could also be used as a 9600 baud modem or a fax modem, with the appropriate software and a little hardware.

The 1120-by-832 pixel resolution presents a sharp, clean image.

The cube is connected to the monitor by a 3-meter (almost 10-foot) cable. The Sony monitor is a 17-inch, high-resolution gray-scale display. The 1120-by-832 pixel resolution is higher than most 19-inch displays (at 1024-by-768), and presents a sharp, clean image. It's easier on my eyes than anything I've brought home. The base rolls easily on a tractor-style wheel, and allows tilting (but not swiveling) the screen. A 3-inch, high-performance speaker is included in the display. No details were available about color for the Next.

The back of the display has gold-plated RCA jacks for stereo output from the DSP56001, and a stereo headphone jack. There is also a microphone jack, for recording voice mes-

sages or sampling sounds, and the keyboard port. The microphone jack is attached directly to sound input chip that converts sound using the same technology used to digitize telephone conversations. Sound collected through this jack does not go through the DSP, but is suitable for voice mail or the beeps and clunks used with game software. The 84-key keyboard does not boast the PC-style function keys—the mouse interface is supposed to negate the need for function keys. A pair of command keys provide keyboard shortcuts for suitably marked menu entries.

There are several special keys nestled in between the two sections. One key turns the Next computer on or off, two keys control the screen brightness, and another two keys control speaker volume. The keys have a very nice feel, and the keyboard is light and small. My only complaint is that the tilde key (~), so useful in `vi` and `csh`, is over on the numeric keypad.

The Next printer is based on a Canon print engine and costs only $2000 (student price). What makes the printer inexpensive is that the translation of Display PostScript into a raster image for the laser is done by the CPU. This conversion, by the way, is one of the few cases where the CPU is used as a dedicated I/O processor, slowing down other processes. The raster image is blasted to the printer through a serial port at up to 3.8 megabits/second (mbps). The printer works in both 300 dpi (dots per inch), the same as the HP Laserjet or Apple Laserwriter, or at 400 dpi, providing almost twice the resolution (160,000 dots versus 90,000 dots per square inch).

The printer is entirely controlled through the cube, including warnings. It was a delightful moment when the Next "said": "The printer is out of paper."

The printer is entirely controlled through the cube, including warnings or error messages. It was a delightful moment when the Next "said" to my son: "The printer is out of paper." He nearly jumped out of his pants. Voice warnings are part of settable user preferences.

As noted previously, the optical disk is perhaps the most controversial part of the Next. An optical disk looks like an oversize 3½-inch floppy with its 5¼-inch shape, hard plastic case, and shutter covering the surface. Each disk holds 256 megabytes of data, plus an additional 80 megabytes in error-correcting code (ECC) used for reliability. The disk spins at 3000 RPM, 10 times faster than a CD, and slightly slower than a hard disk (3600 RM). The seek time is much slower than a hard disk—only 96 milliseconds (ms; about one tenth of a second) for average seek time compared with 18 ms for the Next optional hard disk.

In a test of reading performance, the optical disk took two and a half times as long to read the same directory hi-

erarchy as the Next hard disk. It would be fair to equate the speed of the optical disk with the speed of the hard disks used in many PC XTs and ATs.

I thought that writing would be much slower on the optical disk. Writing is done in three passes—an erase pass, a write pass, and a verify pass. Much to my surprise, writing took about the same amount of time as reading, between two and two and a half times longer while extracting a `tar` archive on the optical and on the hard disk. Data is written to the optical disk by using a laser to heat an internal film to its Curie point. This permits the realignment of magnetic particles within the disk during the erase and write passes. The disk is read by reflecting the laser beam, now at low power, off the internal film, which reflects the laser differently for ones or zeros. A laser disk can be rewritten many times, and the people at Next claim never to have retired a disk because it wore out.

A problem emerged when I was using the hard disk as the root device. To mount an optical disk, you simply slide it into the front of the cube. A dialogue box identifies the disk. Although mounting the disk goes fine, if I turned off the Next and powered it on again, it had forgotten about the optical disk and would refuse to eject it or mount it. To eject the disk, you use a Next-supplied hex driver slid in through an opening in the cube. Next says this is a bug that should be fixed with the 1.0 release, which has been delayed to be released this month. Some Businessland stores are selling units with .9 software now. Next will provide a free upgrade to 1.0 software when it becomes available.

Software Availability

The Next computer is an attractive machine, with innovative and powerful hardware, and a good, easy-to-use windowing system. Its next challenge is to provide a wealth of software. The real issue is software.

Currently, Next lists 73 companies as registered third-party developers. Among these are Frame Technology and Aldus (desktop publishing software), Neuron Data (expert systems), Lotus (spreadsheet), Informix (Wingz, a hypercard-like spreadsheet and their SQL database), Ashton-Tate (database, word processing, and spreadsheet), Relational Technology (INGRES relational database), Mark of the Unicorn (MIDI sequencing and music composing), and Adobe (Illustrator, a drawing program). There are many more announced products beyond those provided as a sample here.

When new software becomes available, it will be distributed in two ways. If the software is relatively low cost, the user would get new software by taking an optical disk to a Businessland store, and having the software copied to the disk. More expensive packages could be sent on their own $100 disks. The Next, by the way, does permit copying between optical disks in systems with a single drive, but it is not any more pleasant than using a single-diskette Macintosh.

It would be fair to equate the speed of the optical disk with the speed of the hard disks used in many PC XTs and ATs.

At the Businessland price of $9995 for nonstudents, the Next computer is a fast workstation that you can expect to see on many desktops in the next few years. Personally, it combines a lot of what I've always wanted in a UNIX machine—fast, high-resolution display, with flexible hardware, a complete UNIX system, and something the rest of my family can use. It's the first UNIX system I have seen that treats both UNIX experts and mere mortals equally, by providing each with the interface they prefer. □

Rik Farrow is a software engineer for Sherrill-Lubinski, a producer of 2-D object-oriented graphics software. He also wrote UNIX Administration Guide for System V (Prentice-Hall) with Rebecca Thomas. In addition, Mr. Farrow designs and teaches courses on system administration and UNIX system security.

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